CHAPTER 8

MAINTENANCE/COSAL

Throughout this chapter, you will be referred to other publications for additional information on the topic being discussed. To receive the best training possible and to improve your knowledge, you must read the publications and become familiar with the information they contain.

Electronics Installation and Maintenance Book (EIMB), General Maintenance, NAVSEA SE000-00-EIM-160, is an excellent handbook to use to review maintenance organization and to increase your knowledge of electronics maintenance. You should also refer your junior technicians to this manual. As a training aid, it will benefit both you and your command.

Shipboard electronics maintenance consists of the following duties:

1. Performing operational tests to establish readiness.
2. Performing power tests, calibration, nonoperational adjustments, and other prescribed qualitative and quantitative performance measurements to establish functional evaluations on systems and equipments.
3. Restoring or replacing deteriorated or defective parts, and replenishing lubricants, coolants, falters, and other consumable items.
4. Correcting failures and damage during operations.
5. Protecting insulation, insulators, and conductors by removing rust, lint, and conductive and nonconductive deposits of fluid, and protecting equipment from the accumulation of these substances and from man-made hazards.

In short, shipboard electronic maintenance consists of preventative and corrective maintenance on all electronic systems, subsystems, equipments, and test equipment.

Because of the complexity of the electronic equipment and systems we now have on our ships, it is most important that electronics personnel be *properly trained, supervised,* and *available for maintenance* of these equipments and systems at any given time. This means that as the LPO or LCPO, you must *assign* your people *wisely, train* them well, and *establish effective schedules* for routine checks and tests. You also need to ensure that all of your allowed parts, test equipment, and tools are maintained, and that all pertinent forms and publications are available. In this chapter we will discuss the various aspects of supervisory maintenance.

LEVELS OF EQUIPMENT MAINTENANCE

There are three levels of maintenance performed by the Navy: **organizational, intermediate,** and **depot.**

ORGANIZATIONAL MAINTENANCE

Organizational maintenance is performed by and is the responsibility of, you guessed it, you and your technicians, and is performed on your assigned equipment. The phases of organizational maintenance are normally inspecting, servicing, lubricating, adjusting, and the replacing of parts, minor assemblies, and subassemblies.

INTERMEDIATE MAINTENANCE

Intermediate maintenance is the responsibility of and is performed by designated maintenance activities for direct support of using organizations. The phases of intermediate maintenance are (1) the calibration, repair or replacement of damaged or unserviceable parts, components, or assemblies; (2) the emergency manufacture of nonavailable parts; and(3) the providing of technical assistance to using organizations. This includes maintenance performed by aircraft carriers, tenders in support of other ships' public works departments, and officially designated shore activities.

DEPOT LEVEL MAINTENANCE

Depot maintenance is performed on material requiring major overhaul or a complete rebuilding of parts, assemblies, subassemblies, and end items, including the manufacture of parts, modifications,

testing, and reclamation as required. Depot maintenance supports lower categories of maintenance by providing technical assistance and by performing maintenance that is beyond their responsibility or capability. Depot maintenance provides stocks of serviceable equipment by using more extensive facilities for repair than are available in lower-level maintenance activities. This maintenance is normally performed b y naval air rework facilities, depot field teams, naval ammunition depots, naval ordnance stations, naval weapons stations, and naval construction battalion centers. It may be performed at contractor depot level work activities, at commercial facilities, or Navy shipyards during availabilities designated as "voyage repairs," "restricted, " "technical," "regular overhaul," and the like.

CATEGORIES OF MAINTENANCE AT THE ORGANIZATIONAL LEVEL

Maintenance actions are subdivided into groups or categories in several different ways; for example, operational/technical, preventive/corrective, and overhaul/repair. The operational/technical and overhaul/repair categories can be bound together according to the technical knowledge and skill needed to do the work.

OPERATIONAL MAINTENANCE

Operational maintenance is the care and minor maintenance of equipment **using procedures that do not require** detailed technical knowledge of equipment's or system's function and design. This category of operational maintenance normally consists of inspecting, cleaning, servicing, preserving, lubricating, and adjusting, as required. Such maintenance may also include minor parts replacement that does not require the person performing the work to have highly technical skills or to perform internal alignment.

As the term implies, *operational maintenance,* is performed by the operator of the equipment. Its purpose is threefold: (1) to make the operator aware of the state of readiness of the equipment; (2) to reduce the delays that would occur if a qualifiedtechnician had to be called every time a simple adjustment were needed; and (3) to release technicians for more complicated work.

You need to talk with the operators and instill in them your willingness to work with them, as a team, to ensure that all equipment will be maintained in operational readiness. The y should report all equipment defects and irregularities to the ET shop promptly, so that all defects can be corrected as soon as possible, before they become worse.

TECHNICAL MAINTENANCE

Technical maintenance is the restoration of an equipment or system to its normal operating condition through the elimination of electrical and mechanical faults; replacement of unserviceable parts, subassemblies, or assemblies; and aligning, testing, and adjusting affected equipment. This type of maintenance **requires skill and detailed technical knowledge of the equipment.**

The knowledge required for this maintenance can be acquired through experience, individual study, formal naval schooling, observation of the work of skilled personnel, and in-service training (OJT).

Details of technical maintenance (usually referred to in technical manuals as *corrective maintenance)* are given in equipment technical manuals, maintenance manuals, letters, directives, and periodicals.

PREVENTIVE MAINTENANCE

We can reasonably assume that many equipment breakdowns were once minor faults. Some of these minor faults are detectable in their early stages. The ultimate objective of preventive maintenance is to detect and correct these faults early so they will not later result in equipment failure.

Equipment failures are govement in general, by the complexity of the equipment, the demands placed on it, and the abuse to which it is subjected. **Abusing** equipment means failing to follow proper operational procedures and failing to ensure adequate preventive maintenance. As an ET1 or ETC, you must ensure that your personnel are thoroughly familiar with the contents of the MRCs and maintenance publications that apply to the equipment or system on which they are assigned to work. This information will help to prevent equipment abuse and to reduce equipment failures.

ELECTRONIC EQUIPMENT AND SYSTEM MAINTENANCE

At this point in your electronics career, you are probably a proficient maintenance technician for certain equipments and systems, and have developed a positive attitude and confidence concerning these particular equipments and systems. As you advance to ET1 and ETC, your "equipment and systems" responsibilities will increase because you will probably be in a work

center or work group supervisory position. Your positive attitude and confidence will be an asset, and in time, you will become more proficient in managing the maintenance for the additional equipment and systems.

It is almost impossible to become a proficient technician in all electronic equipments and systems; however, as a supervisor, you should have adequate knowledge of all the electronic equipments and systems for which you are responsible. Additionally, you should have at least a functional knowledge (as a minimum) of all peripheral, ancillary, and supporting equipment and systems.

As a supervisor, you should know where all equipments are located, their designations, and their position numbers. Your casualty control folder should help you find equipment locations. With time, as you apply yourself as a conscientious supervisor, identifying and explaining locations, functions, and system operation will become second nature for you.

A good background knowledge of all equipments and systems combined with your maintenance experience and positive and confident attitude will be assets as you work in the following areas:

- Training your technicians (and yourself)
- Minimizing equipment and system downtime
- Providing support to the ship's overall mission

In addition, you will also earn the confidence and support of your subordinates and the confidence and support of your seniors.

ELECTROMAGNETIC INTERFERENCE (EMI)

EMI is an electromagnetic or electrostatic disturbance that causes electronic equipment to malfunction or to produce undesirable responses or conditions that do not meet the requirements of interference tests. The dramatic increase in the types of electronic and electrical equipment since the beginning of World War II has brought about a problem that was given little consideration in previous years-EMI. EMI has become a problem because naval ships and aircraft now contain a large number of complex, sensitive devices that are not always compatible with one another.

As an ETl or ETC, you must be aware of the problems caused by EMI and of the solutions to these problems. No magic is involved in reducing or eliminating EMI; instead, problems are resolved by using everyday, commonsense approaches to maintaining equipment.

SOURCES OF EMI

There are three types (or sources) of electromagnetic interference: natural, inherent, and man-made.

Natural EMI

Natural interference is caused by natural events, such as snow storms, electrical storms, rain particles, and solar radiation. This type of interference is commonly called static or atmospheric noise. It can cause problems with rf communications and older data links between shore, ship, and air; however, it does not cause many problems with modern digital data equipment.

Inherent EMI

Inherent interference is noise within a piece of electronic equipment, caused by thermal agitation of electrons flowing through circuit resistance. (This noise is usually noticed as the background noise heard in a radio receiver when it is tuned to a frequency between stations.)

Man-Made EMI

Man-made EMI is produced by a number of different classes of electrical and electronic equipment. They include, but are not limited to: transmitters, welders, power lines, motors and generators, lighting, engines and igniters, and electrical controllers. These devices can cause severe EMI, which can degrade the operation of shipboard or shorebased data processing equipment.

The discussion of EMI will be directed to the recognition and elimination of the man-made EMI that you are apt to encounter ashore or afloat.

TYPES OF EMI

EMI can be classified by its spectrum distribution. EMI can be either narrowband or broadband interference. These terms refer to the frequency spectrum the interference covers.

Narrowband EMI

Narrowband EMI consists of a single frequency or a narrowband of interference frequencies. Narrowband EMI usually has a minor effect on communications or electronic equipment. It can be tuned out or faltered out.

Broadband EMI

Broadband EMI is not a discrete frequency. It occupies a relatively large part of the electromagnetic spectrum. This type of EMI is usually caused by arcing or corona and causes most EMI problems in digital data equipment. It will be especially noticeable when you are receiving data on digital data links. It is caused by the worn or improperly installed brushes of motors or generators, defective fluorescent lights, arcing of contacts in electrical controllers or stepping switches, ignition systems of motor vehicles, igniters for jet engines, and defective power lines or power transformers.

Improperly bonded lifelines, rigging, jackstays, ladders, and stanchions also produce a significant amount of EMI in a shipboard environment. They act as nonlinear mixing devices and antennas. They receive a number of different transmitted frequencies, mix them, and reradiate them over a broad spectrum.

CONTROL OF EMI

EMI can be controlled or eliminated if some simple procedures are followed and good installation practices are adhered to. We will divide the discussion of EMI control and reduction into two categories: shipboard and shorebased. Many of the problems and procedures for reduction are the same for both types of installations.

Shipboard EMI Control

Shipboard EMI control is greatly simplified for typical electronic and digital-data installation. Because of the ship's steel hull and construction, much shielding and isolation are provided for typical shipboard equipment spaces. This blocks out most broadband interference generated both internally and externally. Five major factors must be considered in shipboard computer and digital equipment installations. They are as follows:

1. Equipment location
2. Equipment shielding
3. System and equipment grounding
4. Interconnection cabling
5. Source of power

EQUIPMENT LOCATION.– Digital and computer equipment should be located in spaces that are free of EMI sources. It should not be located in spaces that contain radars, radio transmitters, or generators or other rotating machinery. Simple attention to the location of digital equipment can reduce or eliminate many sources of EMI.

EQUIPMENT SHIELDING.– Electronic and digital equipment should never be operated with drawers extended, cover plates removed, or doors open. Modern equipment contains EMI reducing gaskets and shields that enclose the equipment. Defeating this shielding can lead to serious problems. Always reinstall cover plates with all fasteners in place. If a cover plate or shield must be removed in the course of corrective maintenance, ensure that the EMI reducing contacts or wire gaskets on the equipment opening are in good condition before the cover or shield is replaced. If the contacts or gaskets are bad, replace them.

SYSTEM AND EQUIPMENT GROUNDS.– System and equipment grounds are extremely important in equipment installations. All cabinets should be grounded together on a common system-ground bus. Normally a main system-ground bus of about 70,000 circular mills (1.5 inches in diameter) or more is run through all spaces. Each equipment cabinet is connected to the system ground by a heavy ground cable. The system ground is securely attached to the hull of the ship and provides a good ground reference for the system. In addition, all equipment cabinets have ground straps bypassing the shock mounts attached to the metal decks or mounting racks. A poor electrical connection will result from paint on ground straps or on the metal decks where the ground straps are mechanicaly attached, All terminal lugs or ground straps used to bond the equipment to the hull or the system ground should be bright, clean, and free of any foreign material. This is also true of grounding studs and the system ground cable. This clean surface ensures a good electrical connection. The grounded cabinets provide a shield at ground potential. This keeps in any signal that might cause a problem somewhere else in the system. It also keeps out stray interference that might cause a problem in a particular piece of equipment.

INTERCONNECTING CABLES.– All interconnecting cables used in shipboard electronic and digital systems should be shielded cables. They should be assembled correctly according to installation

drawings. The shield and connector shell should be electricaly connected and properly secured at either end interconnecting cables may have to be routed through spaces where a potential for EMI exists (such as radar rooms). Cables for digital equipments and audio should never be run in the same cableways as cables carrying rf signals or high-power-pulse cables. The shielding protects the data and voice cables from EMI to a great extent. (This is only true if the cable is properly assembled and carefully routed to avoid strong EMI fields.)

POWER SOURCE.– Power lines for electronic and digital equipment can provide a transmission path for EMI from machinery spaces. Most input power passes through noise elimination filters as it enters the equipment. Failure of power line filters (actually bandpass/band reject falters) is rare but happens on occasion. Unusual random problems in equipment can sometimes be traced to defective line falters. Unusually large transient voltages on power lines may also cause EMI. The easiest way to check this type of problem is with an oscilloscope, an isolation capacitor, and a 10:1 probe. Connect the probe and capacitor in series with the main power deenergized. Apply power and check the scope to determine if excessive noise or "hash" is riding on the input voltage.

CAUTION: Always observe all safety precautions while checking equipment input power.

Shorebased EMI Control

Control of EMI at a shorebased installation requires the consideration of the same factors as for a shipboard system, with two additional factors: site location and soil quality.

These two factors may contribute to the generation of additional EMI. They are discussed in the following paragraphs.

SITE LOCATION.– Shorebased electronic and digital data equipment sites are sometimes built where the need dictates or where a convenient building is available. Such sites often are not ideal. A site built near a large industrial complex, such as a shipyard or a naval aviation depot, may be subject to severe EMI. There can also be power line fluctuations if the shore site and the industrial complex have the same power source. In addition, a large amount of EMI is generated by any welding that may take place in the nearby facility.

Special precautions may be needed if sensitive electronic and digital data equipment are located at sites near a high-noise industrial facility. For example, shielding may be needed around an especially sensitive piece of equipment to ensure its proper operation.

Additional line falters and regulators for power lines may be needed to reduce EMI and provide line power within the limits prescribed by equipment manufacturers.

SOIL QUALITY.– At shorebased installations, a system-ground bus is normally attached to a grounding rod driven into the soil. If the soil is dry, sandy, rocky soil, such as that found in the Southwestern United States and some places overseas, the ground will be poor. (Soil that is not ordinarily a good conductor must be chemically treated to increase its conductivity.) In some cases, a poor ground may act like an antenna. The ground cable can, under these conditions, provide an EMI potential in excess of 5 volts between itself and the power ground. You can check a suspect system ground with an oscilloscope and a 1:1 probe. Using power-line ground as a reference, connect the tip of the probe to thes system ground, and the shield of the probe to the power ground. An excessive amount of noise displayed on the oscilloscope may indicate a system-ground problem.

EMI SURVEYS

EMI surveys are conducted to distinguish which equipment is affected and to determine the extent of interference. An EMI survey is required for new construction ships and for ships receiving overhauls or other major repair work that changes the electromagnetic configuration. As a senior ET, you should also request that an EMI survey be conducted if you experience interference on your equipments that you and others are unable to trace to a malfunction in your own equipment.

The EMI survey must be well planned and coordinated to ensure optimum use of dockside and underway test time. Refer to MIL-STD-1605, Military *Standard-Procedures for Conducting a Shipboard Electromagnetic Interference (EMI) Survey (Surface Ships)* for more detailed information on EMI surveys and reports.

2M PROGRAM

Increased equipment complexity, miniaturization, microminiaturization, and the current high tempo of operational requirements have placed an increasing burden on maintenance personnel and facilities. These

problems have been further aggravated by the varied manufacturing methods and techniques used by equipment manufacturers. Maintenance personnel must be properly trained and certified to make high-quality, reliable repairs to a wide variety of state-of-the-art electronic printed circuit boards and modules. For these reasons and others the Miniature/Microminiature (2M) Electronic Repair Program was developed to provide the following support:

- Proper training in the art of miniature and microminiature repair
- Authorization to procure the tools and equipment to carry out the goals of the program
- Personnel and activity certification conducted by fleet and type commanders

PROGRAM SCOPE

The 2M program objective is to provide the fleet with a **miniature** electronic repair capability at all maintenance levels, afloat and ashore. The 2M program also provides a **microminiature** repair capability on selected ships, intermediate maintenance activities (IMAs), and shore facilities. At each activity, repairs are made to those components that are Source Maintenance and Recoverability (SM&R) coded on the Allowance Parts List (APL) for that maintenance level. The 2M program is also intended to provide organizational and intermediate level maintenance activities with the capability to repair, on an emergency basis only, components coded for discard or depot level maintenance.

CERTIFICATION

The primary way QA is ensured in the 2M program is through annual certification of personnel and repair sites. Inspectors (2M trained) from Mobile Technical Units (MOTUs) are designated by NAVSEA to inspect and recertify 2M sites and technicians annually. To be certified, a site must have onboard two 2M technicians certified at the appropriate skill level for each 2M repair station installed.

For station and technician certification requirements, refer to *Certification Plan* for *2M/ATE Program,* TE000-AA-PLN-010/2M. This publication is available from the publications stock point in Philadelphia, Pa.

Issuance of Identification Cards

When the student/technician has successfully completed the performance tests, the 2M inspector (i.e., MOTU, 2M school) will issue the appropriate ID card, record its issuance, and forward a completed NAVSEA 2M Program Certification/Recertification card to NAVSEA.

2M Inspector Recertification Requirements

Each 2M inspector must qualify for recertification annually by returning to a MOTU. An evaluation/update is conducted at these sites to discuss any changes to training course content, AELs, or techniques in the repair area. The MOTU then makes a recertification recommendation to NAVSEA. Inspector recertification then is provided by NAVSEA or its designated representative.

TRAINING

The 2M training courses are conducted at NAVSEA-sponsored schools at the following locations: FTC Norfolk, Va,; FTC Charleston, S.C.; FTC Mayport, Fla.; FTG Pearl Harbor, Hawaii; and Advanced Electronics School at SSC San Diego, Calif.

SUPPLY SUPPORT

Initial outfitting for ships (excluding new construction) is provided by NAVSEA. Other ships, such as new construction, should obtain their initial outfitting of equipment through NAVSEA, 2M Acquisition Engineering Agent, Naval Underseas Warfare Engineering Station, Keyport, Wash. Consumable items for 2M repair stations are obtained via MILSTRIP by the requesting activity.

Additional documents providing information an the 2M Program include the following:

- *Miniature/Microminiature 2M Electronic Repair Program,* NAVSEAINST 4790.17,
- 2M *Repair Handbook,* NAVSEA TE000-AA-HBK-010,
- 2M *Workmanship Standards,* NAVSEA TE000-AA-HBK-020
- 2M *Reference Data,* NAVSEA TE000-AA-HBK-030

QUALITY ASSURANCE

Basically, 2M QA is preventing the occurrence of defects. QA covers all events from the start of a maintenance action to its completion and is the responsibility of all maintenance personnel. For additional discussion on this topic, refer to the chapter on quality assurance in this manual.

To this point we have discussed the areas of maintenance with which you will be especially concerned as an ETl or ETC. Keep in mind that as your career progresses, you will be more and more involved with the "big picture."

Now let's discuss another area of concern to you as you move up into areas of more responsibilities: supply.

SUPPLY PROCEDURES

You have probably already had many dealings with supply matters; but as you advance to ET1 and ETC, your dealings with supply will become more frequent. Your careful concern will be required. You will become more involved with supply support problems, such as–Why is the part requisitioned not onboard?–Is the equipment supported by COSAL?–and so on. As a senior technician, your understanding of supply procedures and the system will benefit you and, ultimately, will be an asset to your division's maintenance accomplishments.

If your ship's COSAL is not up-to-date, your ship's supply support will be inadequate; and when you requisition repair parts, you will often encounter NIS (not in stock) or NC (not carried) items. Therefore, you must understand how the COSAL "system" operates, so you can have repair parts on board that are justifiable and allowable for actual equipments on board. Your knowledge of the COSAL and your careful coordination with supply will help the supply department maintain an up-to-date COSAL, which in turn will allow your shop to accomplish efficient equipment repairs.

At this point go to supply and ask to use the COSAL *Use and Maintenance Manual,* SPCCINST 4441.170, Read chapters 1 through 4; chapter 5, through section C; and chapter 7, sections B, D, and E. Then return to this manual.

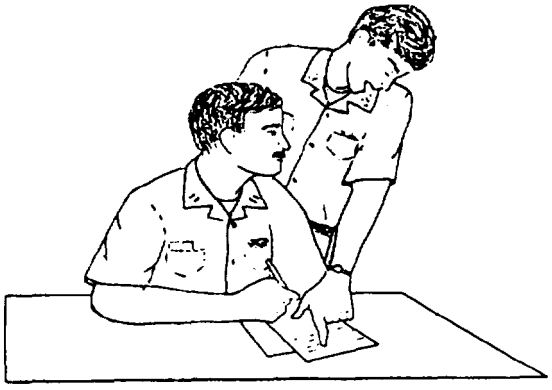
Now that you have completed reading the *COSAL Use and Maintenance Manual,* you should have a basic understanding of how the COSAL is organized and maintained, and how it can help you in your role as a supervisor. Remember to refer to this manual whenever you train your technicians in supply procedures.

SUPPLY AND YOUR MAINTENANCE DIVISION

The following paragraphs are based on a senior technician's thoughts toward supply. To best use your supply system, keep these thoughts in mind:

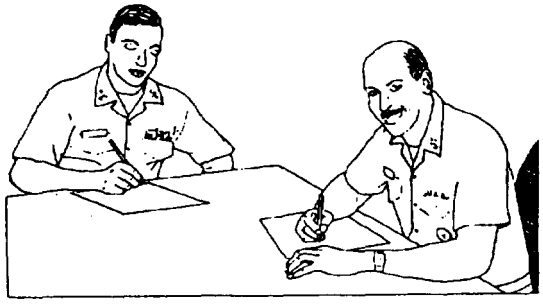
- Take great care in selecting your supply petty officer. Choose someone whom you believe will be accountable and will keep good records; someone who will ask for guidance from you or your supply department should he or she run into any supply-related troubles. This individual should not be someone who has just checked on board from A school, but someone who has some experience in the rating.
- Know how the supply system operates and understand the COSAL, at least as it applies to your electronics maintenance actions.
- Use the supply system as it is set up and designed to function.
- Stay away from bulk ordering of parts, because one order of 20 of an item has the same supply "hit rate" as one order of 1 of that same item. One of supply's bases for stocking an item is the number of "hits" (orders) within a certain time frame. To ensure that supply maintains a sufficient stock of the parts you need, order a few parts several times rather than many parts a few times.
- At least three months before deployment, assist the EMO with a listing of parts (with stock numbers) that you know or feel will be used or needed to support your systems and equipments. This list of parts will be checked with supply to

ensure availability of these items for your upcoming deployment.

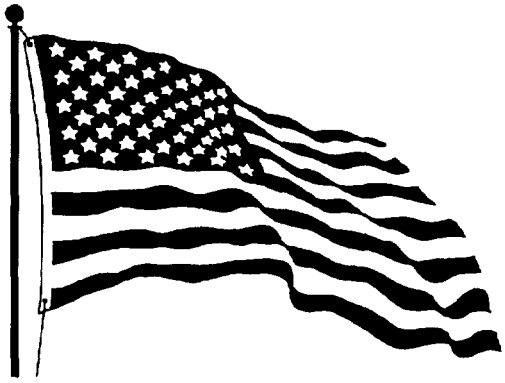


For the items not shown in stock, you or the EMO should ensure the items are ordered for stock. For critical items, conduct a storeroom sight verification to ensure that each part is actually there. You can do this if you have a good relationship with supply.

- Ensure that all paperwork associated with maintenance and supply is well managed and is completed and submitted on time. These documents concerning maintenance and parts used will ultimately assist you in parts support.
- Finally, and this is very important, develop a good working relationship with supply personnel and maintain cooperation. This effort will ultimately be to your benefit in dealing with supply for your repair parts.



Finally, remember that SKILL and *TEAMWORK in the FLEET* will produce, high moral, good working conditions, and a Strong Naval Force for our country.



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